Bile duct injuries

Dr. Anton Sharapov, PGY6
Outline

- Anatomy
- Mechanism
- Incidence
- Classification
- Treatment
- Prevention strategy
Blood supply of CBD

- "normal" is found in only 55% of patients;
- The cranial segments receive blood from the cystic artery and the hepatic arteries, especially the right (R) hepatic artery.
- The caudal segment is supplied from the pancreaticoduodenal artery through the retroduodenal artery.
- The middle (supraduodenal) segment is vascularized by an axial network of a varying number of arterial anastomoses (the average is nine) between the cranial and caudal supplies.
CBD blood supply

- The main branches of the network course on both sides of the common bile duct (on cross-section, at 9 and 3 o'clock)
- Their interconnections are located on the ventral and the dorsal sides
- Another vessel that contributes to the axial supply of the supraduodenal segment is the retroportal artery. It is found consistently, but its origin and mode of termination vary.
CBD blood supply

- 60% by the distal vessels,
- 38% by the cranial ones, and
- 2% by a nonaxial supply from the common hepatic artery.

This arterial pattern predisposes the supraduodenal segment of the common bile duct to ischemic damage and resulting strictures.
Variations in Cystic and Hepatic Ducts

1. Low union with common hepatic duct
2. Adherent to common hepatic duct
3. High union with common hepatic duct
4. Cystic duct absent or very short
5. Anterior spiral joining common hepatic duct on left side
6. Posterior spiral joining common hepatic duct on left side
Aberrant RHD

- 20% incidence of the right anterior or the right posterior ducts joining the common hepatic duct *separately* rather than in the form of a right duct.

- If such a duct is injured it can lead to substantial *biliary stasis or leak*
Accessory (aberrant) hepatic ducts

- Joining common hepatic duct
- Joining cystic duct
- Joining gallbladder
- Two accessory hepatic ducts
- Joining common bile duct
History

- 1882, Carl Langenbuch performed the first open cholecystectomy
- 1905 that Mayo reported the first two cases of bile duct strictures following cholecystectomy.
History of laparoscopic cholecystectomy. Who was 1st?

- French?
- Germans?
- Russians?
- French Canadians?
- Dr. Pace?
Prof Dr. Erich Muhe of Boblingen, Germany

the first laparoscopic cholecystectomy on September 12, 1985
Dr. Muhe’s, the underdog

- 1990 SAGES, Perissat, Berci, Cuschieri, Dubois, and Mouret were recognized for performing early laparoscopic cholecystectomies. Muhe forgotten…
- 1992, receives highest award, the German Surgical Society Anniversary Award.
- 1999 he was recognized by SAGES for having performed the first laparoscopic cholecystectomy, Storz Lecture, entitled "The First Laparoscopic Cholecystectomy", follows.
Cause of CBD injury

- **Yatrogenic - most common**
  - Strictures caused by
    - Calculous disease
    - Pancreatitis
    - Sclerosing cholangitis
    - "Hepatic inflammatory pseudotumors"
      - Aka benign fibrosing disease
      - 10% of all resected “cholangiocarcinomas”

- **Trauma – penetrating & blunt**
  - Associated with major vascular injuries
  - Don’t live to see the consequences…
Viruses
Cytomegalovirus

Toxins
Bacterial Products
Toxic Bile Acids

AIDS-Associated Cholangiopathy
Cryptosporidium
Microsporidia
Cytomegalovirus

Bile Duct Strictures

Immunologic Abnormalities
Immune Complexes
Autoreactive T-Cells
Aberrant HLA Display

Arterial Injury
Chemotherapy
Hepatic Artery Thrombosis
Case

- 54 yof
- Symptomatic cholelithiasis
- Community hospital
- How do you approach issues of consent preoperatively?
Case cont’d

- Pt goes to OR
- Difficult dissection
- Cystic duct is clipped and transsected
- Another duct “shows” up
- This is clipped as “accessory” duct
Back to the case, intraop cholangiogram is obtained...
Case cont’d

- When GB is out – it does not look right..
- What do you do?
Incidence of LC BDI

COLLECTIVE REVIEW

AN ANALYSIS OF THE PROBLEM OF BILIARY INJURY DURING LAPAROSCOPIC CHOLECYSTECTOMY

Steven M. Strasberg, M.D., F.R.C.S.(C), F.A.C.S., Martin Hertl, M.D., and Nathaniel J. Soper, M.D., F.A.C.S.
Bile injury in Open Chole

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Numbers in parentheses are percentages.
No., Number, and pts., patients.
## Bile injury in Lap Chole

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Overall incidence

- 0.5% in Strasburg review, 1995
- 0.4% in Cameron, 2004
- 0.18% in recent 90,000 LC review
- 0.31% in 10,000 Swiss pts’
- Overall spread 0.2-3%
Classification

- Bismuth – level of CBD injury

BISMUTH TYPE

IV (ducts separated)
III (confluence)
II (CHD < 2 cm)
I (CBD ≥ 2 cm)
V (rt. sectoral)
Strasberg-Soper modification

- substratification reflecting causes of bilomas
- Categorizes occlusion of R duct
- Overall, groups have different prognosis and management
Type A

- BL from minor duct
  - Cystic duct leak
  - Liver bed leak
  - Accessory duct leak

- Communication between liver and duodenum via major ducts unaffected
Type B

- **Occlusion** of the part of biliary tree
  - Usually due to R aberrant duct ligature
    - May be segmental, sectorial, main R
Type C

- **Transection** of the part of biliary tree
- No occlusion
  - Usually due to R abberant duct ligature
    - May be segmental, sectorial, main R
- Similar to B but...
- Presents and treated differently from B
Type C

- Bile duct **leak from duct not in communication with common bile duct**
- Bile drains into peritoneal cavity
- Both B & C **disconnect a portion of liver parenchyma from main biliary tree**
Type D

- Lateral injury to main extrahepatic bile ducts
- Similar to A
  - Bile collection
- Dissimilar to A
  - Location on the main bili tree
  - Consequences more severe
- RHD, CHD, CBD may be involved
Type E (Bismuth class 1-5)

- Circumferential injury
- Combination injury (E5)
- Separation of parenchyma from ducts
- No specification of length
  - In original classification
Type E: pictures
Types of injury
Back to the case

- PTC is requested
Frequency of injury

- Srasberg et al, 270 case series, 1995
- Tertiary center
- A – 62 23%
- B – 1 0.004%
- C – 8 0.03%
- D – 24 0.09%
- E – 175 65%
- Mostly 1-4, even distribution
Incidence

- Surveys indicate A and D more predominant in common practice
- Tertiary centers have predominance of E type
  - Secondary to referral
- B are usually underreported
Direct causes of laparoscopic injury

- **Misidentification** of anatomic structure
- **Technical** error
- Several patterns observed
Risk factors to BDI

- Local operative factors
  - Inflammation
  - Bleeding
  - Fat/scar

- Aberrant anatomy

- Equipment
  - Laser used dissection initially
  - High Cautery setting
  - Insulation breakdown
  - 0 vs 30 degree scope
Other factors to misidentification

- Short cystic duct
- Large stone in Hartmann’s pouch
- Tethering of GB to CBD
- Extensive dissection leading to devascularization of the duct
Technical errors

- Failure to occlude cystic duct
  - Tie better then clip?
  - Clip “scissoring”
  - Thick cystic duct?
  - Unrecognized choledocholithiasis
    - CBD pressurized
- Deep plane of dissection on liver bed
- Thermal injuries
Direction of traction

- “American” vs “European” technique
  - GB pulled alongside vs away
  - Difference in port/surgeon positioning
- Similar rates of injury in US/Europe
Tenting

- CBD pulled up with cystic and clipped
- Not a common cause
In other words, dangerous...

- ...Pathology
- ...Anatomy
- ...Surgery
- Contribute to BDI
Experience important?

- Training and experience
- Recent studies show that many injuries occur after the surgeon has had considerable experience
- Some attribute injuries primarily to perceptual errors independent of experience or patient factors
Illusions – are they a factor?

- 252 BDI, videotaped,
- analysed according to the principles of the cognitive science of visual perception, judgment, and human error.
- Compelling anatomic illusions to which everyone is susceptible are the primary causes of bile duct injuries;
- experience, knowledge, and technical skill by themselves are insufficient protection against this complication
The white triangle and a dalmatian... Are they there?
The white triangle and a dalmatian... Are they there?
Patterns of injury

- “classical injury” – picture
  - CBD mistaken for cystic
  - CBD clipped and transected
  - CBD additionally divided +/-clipped proximally
    - Above bifurcation
  - Occasional R hepatic artery injury
Patterns of injury cont’d

- Clipped cystic duct/cut CBD
Clipped/cut aberrant duct...
Prevention:

- Training is essential
- Experience is essential
- Guidelines for identification
- “Critical view of safety dissection”
- Calot’s triangle free from
  - Fat, fibrous, areola tissue
  - Lower end of GB dissected off liver bed
Dissection points

- Dissect close to GB
- Inferolateral traction on Hartmann’s
- CBD may have small diameter
- CBD may have associated vessels
Dissection points

- If can’t occlude Cystic duct with clips...
  - Is it cystic duct?
  - Use ties after critical view is obtained...
- Any tubular structure is CBD until proven otherwise
Suspect CBD, *not* cystic duct, if:

- Clipped duct is not fully encompassed by a standard clip (9mm)
- Duct can be traced to go behind the duodenum
- Presence of another unexpected ductal structure
- A large artery (RHA) behind the duct
- Extra lymphatic & vascular structure seen
- Proximal hepatic ducts fail to opacify on IOC
Intraop cholangiogram?

- Routine intraoperative cholangiography - Fletcher et al. in 1999
- retrospective study of 19,000 cholecystectomies
- protective effect for complications of cholecystectomy
IOC and US...

- Routine *intraoperative laparoscopic US with selective cholangiography* reduces bile duct complications during laparoscopic cholecystectomy.

- Biffl WL - *J Am Coll Surg* - 01-SEP-2001;193(3)
  - 842LC, 0.006% incidence of BDI
Operative cholangiography

- is best at detecting **misidentification of the CBD as cystic duct**
  - will prevent excisional injuries of bile ducts
  - **Only if** the cholangiogram is correctly interpreted.

- **Poor at detecting aberrant right ducts**
  - join cystic duct before joining CBD
Preoperative CT assessment
Presentation of biliary injury

- A and E – biloma
- Important differences...
### Differences in A and E presentation

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<td>Intraop ds?</td>
<td>rare</td>
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<td>Presentation after 30/7?</td>
<td>rare</td>
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<td>Jaundice?</td>
<td>Very uncommon</td>
<td>&gt;66%</td>
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<td>Pain, fever, sepsis with no jaundice?</td>
<td>&gt;50%</td>
<td>&lt;15%</td>
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<tr>
<td>Lab test</td>
<td>ALP up</td>
<td>TB &gt;50, ALP up</td>
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A – early, pain, fever, sepsis, ALP, TB up, no jaundice.
E – jaundice and pain
C and D may present as A
Goals

- Treat/Relieve complications
  - Sepsis, obstruction, fistula
- Characterize bile duct injury
- Treat injury
- Follow-up
Approach to diagnosis

- If pain, fever, sepsis, no jaundice (i.e. likely A) – US or CT to evaluate & drain collection
- If bile is found – can use HIDA to see if leak is active
- If leak is active, then ERCP will characterize it and treat it (stent, sphincterotomy)
Approach cont’d

- If jaundice – start with ERCP +/- US
- ERCP won’t characterize proximal biliary tree
- PTC is invaluable
  - May be difficult if no dilation
  - Can drain effectively -> temporize
- If already draining bile - fistulogram
Which BDI are seen intraop?

- Intraoperatively, C, D, or E injuries are seen
- If recognized, need to convert to open
When to repair?

- Ideally, intraoperatively at first operation or ASAP
- Otherwise, if no experience - drain and refer
  - Phone call from OR is helpful!
- If injury took place > 72h, try to temporize at least 8/52, ideally 12/52
- Let inflammation settle and thermal/devascularization injury to manifest itself fully
- If uncontrolled sepsis - then no delay
Surgery

- Contemplated with pt is stable, cooled off
- When injury is characterized
  - Account for *every* segmental duct
  - Failure of operation seen in …
    - 96% of cases when no preoperative cholangiogram obtained
    - and in 69% when the cholangiographic data were incomplete
Type A:

- Cystic Duct Leak Study Group
- 22,000 LC
- 55 pts with persistent bile leaks
- ERCP used to treat 31 with 87% success
- Perc Drain, laparoscopy/tomy used
- 98% success overall
Endoscopic internal stenting

- Reduces pressure gradient
- Procedure of choice for treating bile duct leaks
- 7 & 10 Fr stents can be inserted without sphincterotomy
- Prompt therapeutic response seen
- Cessation of bile extravasation in 70-95% of cases within a period of 1-7 days.
Type B

- Most asymptomatic
- Usually present late or discovered incidentally
- If affected segment small – no Tx
- If large and cholangitis – consider hepaticojejunostomy vs segmental resection
Type C

- Oversew if duct is less then 2 mm
- Otherwise, enteric anastomosis
Type D

- Some can be treated with stent
- Repair over a T tube
  - Intubate or separate stab
  - Drain
Type E

- Hepaticojejunostomy
- Hepaticoduodenostomy
  - Usually avoided – too much tension
- End-to-end
  - IF no loss of length and clean cut
  - But: higher incidence of stricture…
  - Some do not recommend due to ischemia of CBD
    - Remember axial blood supply is poor
    - Supply from below is transected by BDI
Back to the case

- Patient is admitted to tertiary care center
- E3 injury is diagnosed
- Urgent (within 48h) choledochojejunostomy is carried out
Principle of repair

- Tension free
- Mucosa to mucosa
- Adequate diameter
- Roux-en-Y for most
  - To jejunum, avoid duodenum
- Selective use of stents and T-tubes
- May need to dissect ducts with parenchyma
- Alternatively, drain and refer, particularly if E3-5
- Address all concomitant injury
  - To RHA, portal vein, etc
Alternative methods of high E repair:

- Long side to side if ducts narrow
- For difficult R duct repair…
  - If Bifurcation is preserved, divide hepatic plate and anastomose to LHD
    - Hepp-Couinaud approach
  - Resect portion of liver parenchyma (4b & 5) to expose R duct
- Stents only for small caliber repair
Enterotomies

Posterior rows of anastomoses

Biliary duct
Failure of hepaticojejunostomy

- Level of injury
  - the higher - the poorer the outcome after the procedure.
- other factors include the
  - timing of the repair,
  - performance of preoperative cholangiography,
  - choice of surgical procedure,
  - the expertise of the surgeon performing the repair,
  - and the presence of concomitant vascular injury
    - If combined bile duct and hepatic artery injury present, 75% will have liver necrosis and/or abscess and 50% of the bile duct anastomoses will fail.
Outcomes

- Progressive re-stenosis rate
  - 5-28%
- 2/3 diagnosed in the first 2 years
Back to the case

- Pt is f/u closely
- Re-admitted with RUQ pain, jaundice
- Liver enzymes up
- What’s going on?
- What’s next?
Case

- Unable to see hepaticojejunostomy
- Dilated intrahepatic ducts
- What next?
- Re-do operation
Case completed

- Pt had revision
- Difficulty identifying R duct
- Post op well
- HIDA scan shows drainage

IMMED
Long term complication

- Stricture
- Sepsis
- Liver failure
- litigation
References

- Cameron, 2004
- Biliary Injury in Laparoscopic Surgery: Part 1. Processes Used in Determination of Standard of Care in Misidentification Injuries. Steven M Strasberg, MD, FACS, JACS, October, 2005
- Surgical Case Presentations at Department of Surgery, SUNY Downstate.htm